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Original Article

Avoidable Mortality Differences between Rural and Urban Residents During 2004–2011: A Case Study in Iran

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ABSTRACT

Background: Avoidable mortality as an indicator for assessing the health system performance has caught the attention of researchers for a long time. In this study we aimed to compare the health system performance using this indicator in rural and urban areas of one of Iran's southern provinces.

Methods: All deaths (29916) which happened during 2004–2011 in Bushehr province were assessed. Nolte and McKee's avoidable deaths model was used to distinguish avoidable and unavoidable conditions. Accordingly, all deaths were classified into four categories including three avoidable death categories and one unavoidable death category. STATA software was used to conduct Poisson Regression Test and age-standardized death rate.

Results: Findings showed that avoidable mortality rates declined in both urban and rural areas at 3.33% per year, but decline rates were influenced by Ischemic Heart Disease (IHD) and preventable death categories to treatable death category. Annual decline rate for IHD category in rural and urban areas was nearly the same as 8%, but in preventable death category, rural areas experienced more decreases than urban ones (7% vs 5% respectively). However, decline rate in treatable mortality neither in urban and nor in rural areas was statistically significant.

Conclusion: Despite the annual decline in the rate of avoidable deaths, policy making initiatives especially screening and inter-sectoral measures targeting cause of deaths such as colon and breast cancers, hypertension, lung cancer and traffic accidents, can still further decrease avoidable deaths in both areas.

Background

Measuring health system performance has been critical, challenging and a complex issue for a long time (1–3). Most of the efforts targeting this issue, have been focused on developing a comprehensive indictor which can evaluate the role of health system on population health (3–5). Avoidable death is among the several developed indicators which measures health system performance, caught the attention of researchers exactly after introducing the notion of "unnecessary untimely deaths" in 1976 by Rutstein and colleagues (1,4,6,7). Ever since, the concept has experienced some modifications and been used by many researchers in different approaches (6,8,9).

The fundamental presumption in applying this method is that, healthcare systems effectiveness can be evaluated through tracking the rates of deaths due to some special conditions. In this regard, effective medical care interventions has been practical or they could be prevented through timely and appropriate measures (6,10,7). Conducted studies have mostly shown that the rate of avoidable deaths by time has declined. As such, their scale and pace with regard to sex, ethnic, age groups and socioeconomic quintiles have been different (7–9,11–14). In Iran over the past three decades, in particular after the establishment of healthcare networks, mortality rate among the provinces has fallen differently and considerably (15–17). As such, the difference in mortality rates between rural and urban areas has been narrowed (18,19), but this question has still remained unanswered that how much of these recent declines can be attributed to healthcare contribution and also whether rural and urban residents have equally benefited from this kind of progress. In this study we aimed to measure health system performance by following the trend of healthcare indicator and also inter-sectoral health policy between urban and rural residents during 2004–2011 in one of southern provinces in Iran.

Methods

This is a trend study carried out in one of southern provinces of Iran. Data including all deaths (29916) happened during 2004–2011, was obtained from the of registered deaths in the Ministry of Health and Medical Education. In Iran deaths

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registration according to International Classification Of Disease (ICD-10), fundamentally started in 1997 in Bushehr province as pilot (15,20). Therefore, Bushehr province (Table 1), as the most experienced geographical unit of death registration in Iran, was chosen as the site of study (21). Nolte and McKee's avoidable deaths model with some exceptions was used to extract avoidable deaths (5). Accordingly, all deaths during 8 years were classified into four categories including: a) treatable deaths (i.e. conditions amenable to medical care interventions), b) preventable deaths (i.e. conditions which lack effective treatment and are mainly avoidable by primary prevention and are in the framework of inter-sectoral interventions), c) Ischemic Heart Disease (IHD) and d) unavoidable deaths (Table 2). Totally 0.57% of deaths lacked diagnostic codes which were placed in unavoidable deaths category. In practice, we firstly extracted all codes in Table 2 from the total registered death codes as avoidable death codes, and then assigned the number of deaths for each cause of avoidable death in order to determine the number of avoidable deaths and finally with regard to possibility of treatment or prevention, they were divided into four categories to conduct required analyses.

Age limit for most causes of death was determined as 74 years, because the reliability of death certifications in terms of exact registration of major or underlying cause of death in upper ages is low. Asthma and AIDS were included in the list of avoidable deaths, because of the possibility of their treatment and prevention (8). We also put IHD in one special group for two reasons; firstly, the number of deaths from this cause is relatively high and therefore would probably affect the share and role of other causes and secondly, it is believed that both health policy and medical care interventions could prevent occurring deaths due to IHD (11,22). Age-standardized mortality rate was calculated for both rural and urban areas with considering Iran's population in 2006 as a reference. Poisson regression was used to calculate relative risk for exposure to avoidable deaths between urban or rural populations as well as annual decline rate. Data analysis was conducted using STATA 11 (Stata Corporation, College Station, Texas) and Microsoft Excel 2007 software.

Results

Findings indicate that a total of 29916 deaths occurred during the study period, of which 10741 were avoidable and the rest (19175 deaths) were unavoidable. By comparison, urban areas represented 18729 (62.60%) of total deaths, of which 6777 (36.20%) were considered as avoidable and 11952 of them were unavoidable. The proportion of avoidable deaths in rural areas in spite of having less share of total mortality was nearly equivalent to urban areas (37.40% vs 36%). Furthermore, the maximum and minimum share of avoidable deaths in both urban and rural areas belonged to treatable and IHD mortality categories respectively (Table 3). Findings of the study also revealed that avoidable death rates in rural areas in comparison to urban areas in all three categories of avoidable deaths in the first three years were pronouncedly higher.

Table 1. Some characteristics of Bushehr province and national comparators

Indicators	Province	National comparators
Population	1032949	75149669
Crude mortality rate (per 1000)	4.00	4.50
Male to female ratio	1.19	1.02
Household size	4.20	3.50
Population growth rate	3.11	1.29
Literacy rate	83.64	84.75
Urban to rural ratio	2.14	2.49

As Table 4 and Figure 1 show, the trend of avoidable deaths in both IHD and preventable death categories was decreasing. However, the trend in treatable death category in rural areas was nearly stable and in urban areas was on the rise. Poisson regression showed that annually reduction rate in preventable death category for urban and rural areas was 5% and 7% respectively ($P<0.01$). As such, in IHD category the rate of decline over the study period for urban areas was at 8% per year ($P<0.01$). This decreasing trend in IHD category was also observed in rural areas at 8% annually ($P<0.01$). But both urban and rural populations had insignificant increasing and decreasing rates in treatable avoidable category respectively. However, during the study period, unavoidable deaths rate significantly increased at 0.71% per year ($P<0.05$; Figure 2). Table 4 shows that the highest rate of avoidable deaths in both urban and rural areas during the 8-year study period happened within the first three years of study and that the highest rate was related to treatable mortality category (77.60 and 83.10 in 100000 population in rural and urban areas respectively).

Calculation of relative risk using Poisson regression showed that, the probability of exposure to avoidable death among the residents of rural areas after adjusting the effect of variables including year, age, and population, was higher than the urban ones at 13% ($P<0.01$).

Comparison of avoidable deaths trend between urban and rural areas signified that the reduction rate in rural population was higher. This claim is confirmed through the calculation of annual reduction of avoidable deaths rate in rural and urban areas at 5.20% and 3.64% ($P<0.01$, CI 0.06–0.03 and $P<0.01$, CI 0.05–0.00) respectively.

Extracted results also implied that the maximum number of avoidable deaths in both urban and rural areas was placed the age group of 65–74. Meanwhile, the least share of avoidable deaths was represented by 35–44 age group. Generally, about 46% of total avoidable mortality occurred in the first and last age group (Table 5).

Regarding the major groups constituting avoidable deaths makes it clear that, cancers group during the 8-year study period accounted 7.43% of the total avoidable deaths, in which lung cancer, leukemia, breast and colon cancer had the most contribution. Comparing the chance of exposure to death due to cancers between urban and rural areas showed that relative risk for exposure to colon and breast cancers among the rural residents compared to urban areas was at 37% ($P<0.05$), and 30% ($P<0.05$) respectively (Figure 3), but regarding the other kinds of cancers, differences were not statistically significant. Totally, of 790 deaths due to cancers, about 261 (33%) cases occurred among the rural population and the rest (529) were among the urban residents (Table 1).

Deaths due to circulatory system including: IHD, cerebra-vascular disease, hypertensive and chronic rheumatic heart disease altogether were considered as the largest contributors among the avoidable conditions. Totally, of 4237 (39.45%)

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Table 2. Causes of death considered as avoidable

Cause of death		Age range (year)	ICD-10	Number of deaths
Medical care indicators (treatable death)				
1	Intestinal infections	0–14	A00–A09	26
2	Tuberculosis	0–74	A15–90, B90	39
3	Other infections (diphtheria, tetanus, septicemia and poliomyelitis)	0–74	A35, A36, A80	27
4	Viral hepatitis	0–74	B15–19	50
5	Whooping cough	0–14	A37	0
6	Measles	1–14	B05	0
7	Malignant neoplasm of colon and rectum	0–74	C18–21	79
8	Malignant neoplasm of skin	0–74	C44	19
9	Malignant neoplasm of breast	0–74	C50	146
10	Malignant neoplasm of cervix uteri	0–74	C53	30
11	Malignant neoplasm of cervix uteri and body of uterus	0–44	C54–55	6
12	Malignant neoplasm of testis	0–74	C62	5
13	Hodgkin's disease	0–74	C81	20
14	Leukemia	0–44	C91–95	166
15	Disease of thyroid	0–74	E00–E07	36
16	Diabetes	0–49	E10–E14	119
17	Epilepsy	0–74	G40–41	45
18	Chronic rheumatic heart disease	0–74	I05–I09	16
19	Cerebrovascular disease	0–74	I60–I69	1201
20	All respiratory disease	0–14	J00–09, J20–99	33
21	Influenza	0–74	J10–11	0
22	Pneumonia	0–74	J12–18	198
23	Asthma	0–74	J45–46	95
24	Peptic ulcer	0–74	K25–27	41
25	Appendicitis	0–74	K35–38	9
26	Abdominal hernia	0–74	K40–46	15
27	Hypertensive disease	0–74		368
28	Cholelithiasis and Cholecystisis	0–74	K80–81	6
29	Nephritis and Nephrosis	0–74	N00–07, N17–19, N25–27	306
30	Benign prostatic hyperplasia	0–74	N40	0
31	Misadventures to patients	0–74	Y60–Y69, Y80–Y84	36
32	Maternal death	0–74	O00–O99	43
33	Congenital cardiovascular anomalies	0–74	Q20–28	279
34	Perinatal death (all causes excluding stillbirths)	0–74	P00–96	1209
Health policy indicators				
35	AIDS	0–74	B20–24	41
36	Malignant neoplasm of trachea, brunches, and lung	0–74	C33–34	319
37	Cirrhosis of liver	0–74	K70, K73–4	88
38	Motor vehicle accidents	0–74	Vo1–99	2973
IHD				
39	Ischemic heart disease	0–74	I20–I25	2652
Unavoidable death				
40	Unavoidable deaths	All ages	All remaining codes	19175

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Table 3. Frequency and percentage of avoidable deaths by different groups of avoidable death in urban and rural areas during 2004–2011 in Bushehr province

Death category	Urban (%)	Rural (%)	Total
Treatable	3006 (16.05)	1662 (14.85)	4668 (15.60)
Preventable	2096 (11.19)	1325 (11.84)	3421 (11.44)
IHD	1675 (8.94)	977 (8.74)	2652 (8.86)
Unavoidable death	11952 (63.82)	7223 (64.57)	19175 (64.10)
Total	18729 (100)	11187 (100)	29916 (100)

Table 4. Age-standardized rates of avoidable deaths (per 100000 population) in different avoidable death categories by place of residence during 2004–2011 in Bushehr province

Year	Rate in urban areas			Rate in rural areas			Total rate
	TMR	PMR	IHD	TMR	PMR	IHD	
2004	290 (56.30)	281 (50.10)	249 (56.40)	187 (68.80)	207 (72.80)	177 (68.30)	1391 (178.70)
2005	339 (67.70)	301 (55.40)	225 (50.70)	235 (83.10)	202 (69.50)	123 (46.50)	1425 (182.20)
2006	399 (77.60)	239 (43.40)	199 (45.00)	211 (72.40)	189 (62.20)	136 (49.10)	1373 (172.90)
2007	367 (69.00)	280 (49.30)	231 (49.50)	214 (75.20)	139 (47.80)	122 (45.60)	1353 (169.10)
2008	401 (74.20)	232 (39.80)	233 (48.50)	225 (81.60)	143 (50.30)	134 (51.80)	1368 (170.50)
2009	405 (70.80)	270 (44.50)	195 (39.40)	187 (70.40)	163 (58.20)	94 (37.40)	1314 (159.40)
2010	363 (62.20)	227 (36.80)	177 (34.60)	209 (82.20)	152 (58.10)	100 (41.30)	1228 (147.40)
2011	442 (72.40)	266 (39.60)	166 (28.00)	194 (63.00)	130 (38.30)	91 (31.30)	1289 (147.30)

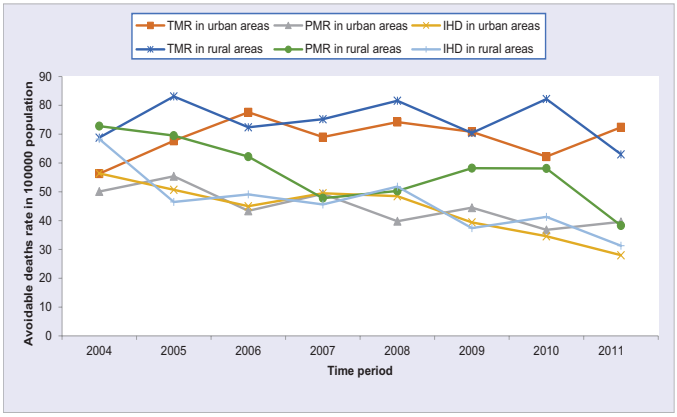

Figure 1. Age-adjusted avoidable deaths rate during 2004–2011 in urban and rural areas of Bushehr province

TMR= Treatable Mortality Rate, PMR= Preventable Mortality Rate, IHD= Ischemic Heart Disease

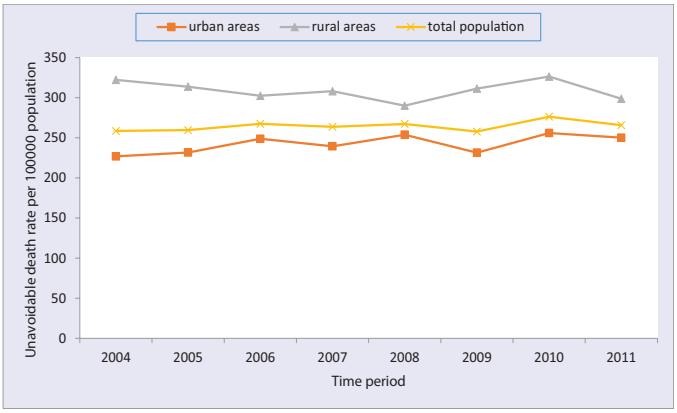

Figure 2. Unavoidable deaths rate during 2004–2011 in urban and rural areas of Bushehr province

avoidable deaths attributed to this major group, 2616 (61.74%) belonged to residents of urban areas and the other 1621 happened in rural areas (Table 1). Poisson regression showed that relative risk of exposure to deaths due to hypertensive diseases among rural residents was 56% higher than the urban residents ($P<0.01$), but both areas had the same chance for dying owing to cerebra vascular diseases (Figure 3).

Findings also revealed that there was a significant difference between rural and urban areas in terms of exposure to death from kidney-related diseases ($P<0.05$) and diabetes mellitus ($P<0.01$), and rural residents had less chance than their urban counterparts for deaths owing to kidney-related disease and for diabetes (24% vs 41%). Results also showed that during the study period, both rural and urban residents experienced a decreasing trend in death rates from road-related traffic accidents at 6% per year, but relative risk for rural areas in comparison to urban ones was 1.35 times greater (Figure 3).

Perinatal period deaths also indicated that, of 1209 deaths related to this group, 820 (67.82%) of them had happened in

Table 5. Frequency and percentage of avoidable deaths by age group and residency during the 8-year study period in Bushehr province.

Age group	Rural (%)	Urban (%)	Total
0-14	708 (17.87)	1294 (19.09)	2002 (18.63%)
15-24	455 (11.48)	732 (10.80)	1187 (11.05%)
25-34	333 (8.40)	596 (8.81)	929 (8.66%)
35-44	264 (6.66)	552 (8.14)	816 (7.60%)
45-54	426 (10.74)	779 (11.50)	1205 (11.21%)
55-64	591 (14.91)	1078 (15.90)	1669 (15.54%)
65-74	1187 (29.94)	1746 (25.76)	2933 (27.31%)
Total	3964 (100)	6777 (100)	10741 (100%)

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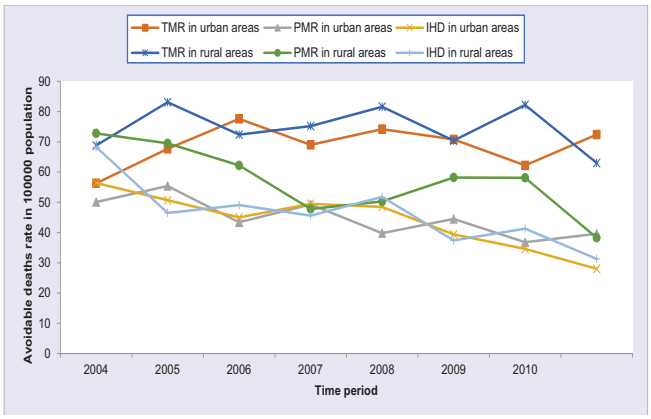

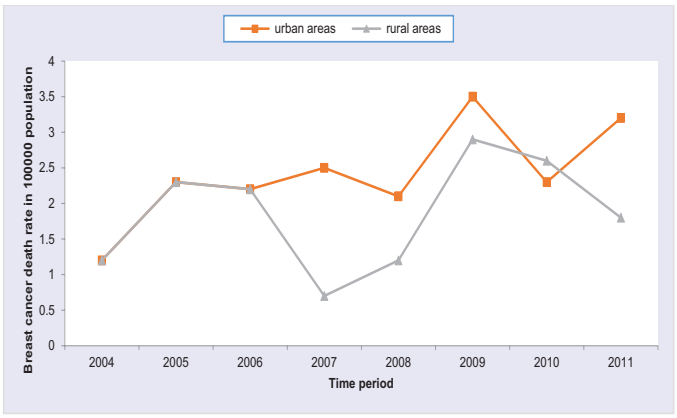

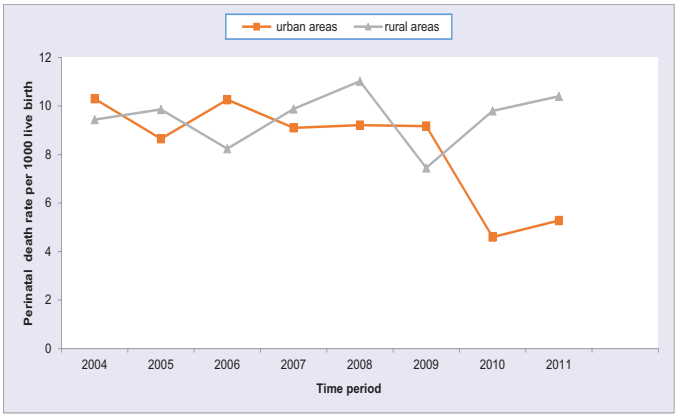

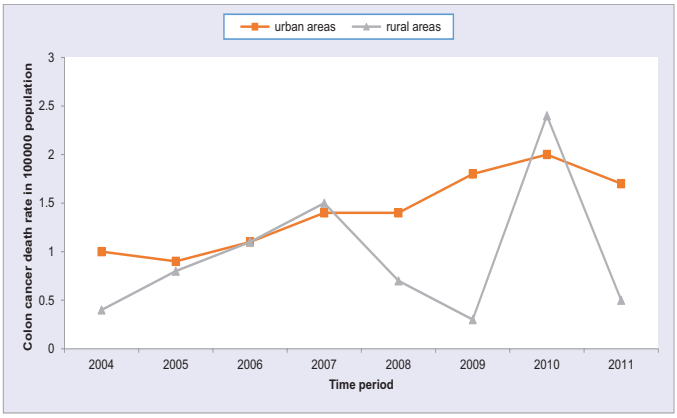

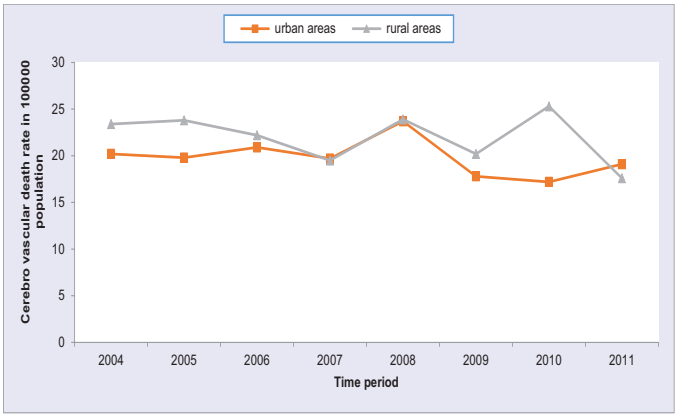

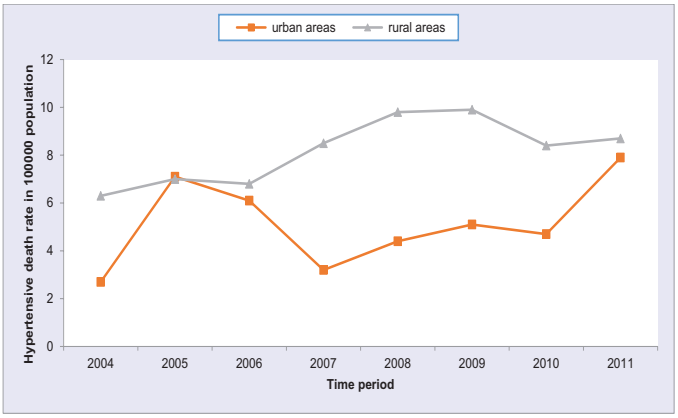

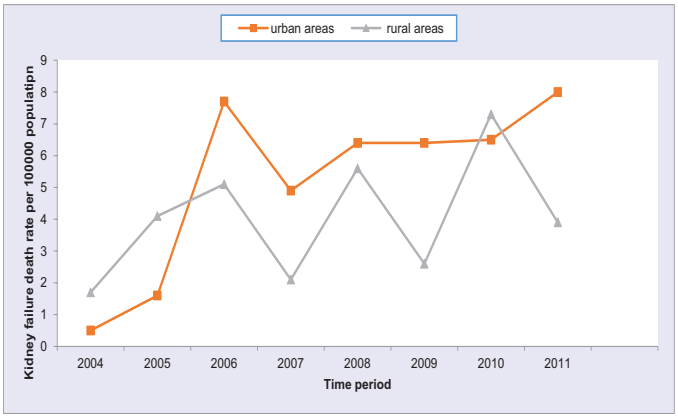

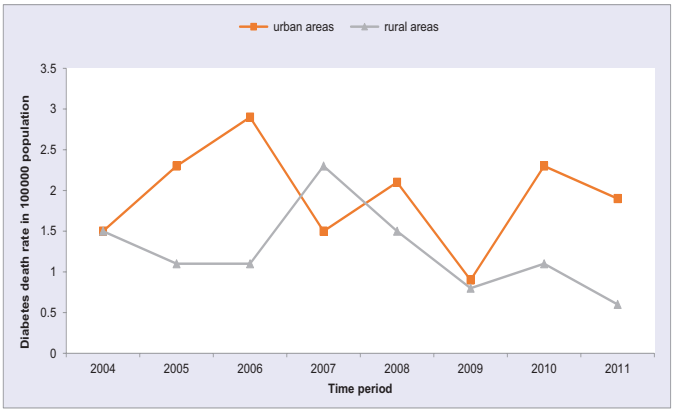

Figure 3. Age-adjusted avoidable deaths rate for some conditions during 2004–2011 in urban and rural areas in Bushehr province

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urban areas and the rest were related to rural areas (Table 1). There was a significant difference between rates in both areas during the study period and also a higher relative risk of exposure to perinatal death was observed in rural areas ($P<0.05$; Figure 3). Findings also made clear that, of 41 deaths from AIDS 38 cases had occurred among the urban population (Table 1).

Discussion

One of the leading results of this study was that the rate of avoidable mortality in both urban and rural areas had fallen. Most importantly, this reduction could be mostly influenced by IHD and preventable categories rather than treatable death category. Observed decreasing trend of avoidable mortality is consistent with other studies (4,6,7,9,23–25), but regarding the contribution of different groups of avoidable deaths in total reduction, our results are inconsistent with some of those studies. Our results revealed that the annual treatable mortality rate in both areas did not decrease significantly. In addition, according to the findings of Ollandes *et al.* in Greece, Corda *et al.* in Australia and Niti *et al.* in Singapore, decline in treatable mortality rate was also remarkable (4,6,7).

Based on the study findings, the annual increasing trends for treatable conditions such as breast and colon cancers, pneumonia, hypertensive diseases and kidney failure are the major impediments in the success of health system in declining the rate of deaths due to treatable causes. Furthermore, Poisson regression showed that relative risk of exposure to treatable deaths among the rural residents after controlling the effect of age, sex, population and year was 13% further than their counterparts. The higher rate of death from hypertensive diseases in rural areas is a determining factor regarding such an inequality in relative risk between rural and urban areas. Not only, program integration does not exist in the structure of Bushehr heathcare networks to deal with related risk factors, but also the lack of immediate access (26) to specialists for diagnosis and proper treatment and inattention to hypertension risk factors in rural areas are some salient points that cause a high rate of death owing to hypertensive diseases in comparison to urban areas. In addition, with regard to the report of Iran's health perspective, hypertension risk factors in Bushehr province are relatively higher than the other provinces (27). This increasing trend in deaths which are the result of high blood pressure is against the obtained results of Chung *et al.* in South Korea (9).

Findings also showed that like other studies (4,5,7,11), IHD death rate decreased and relative risk was nearly equal for residents of both areas. Access to healthcare services through the increased number of diagnostic and treatment centers, hospital beds, general practitioners, specialists and other medical staff during recent years in Bushehr (28) have helped this decreasing trend.

Assessment of preventable death rates indicates that both urban and rural residents have experienced a decreasing trend, but relative risk of exposure to preventable deaths is still 27% further in rural areas which has mostly been affected by road traffic accidents. Resent improvements in the quality of roads, installing the speed recording cameras, fastening compulsory seat belts, TV advertisements, increasing the fines due to breaking the driving laws and also mandating car manufactures to install options for increasing safety like air bags and advanced brakes along with increasing the number of road emergency centers (28) may help reduce the mortality rate, but it seems that disproportionate distribution of facilities such as road emergency camps and unequal access to emergency services have been effective in the higher rate of death from road traffic accidents in rural areas.

With regard to our findings, the rate of deaths owing to other preventable conditions such as lung cancer and AIDS is higher among the urban residents compared to rural areas. More well-prepared environmental situations in urban areas may facilitate access to routes of AIDS transmission and finally led to the variation in deaths due to AIDS between rural and urban areas. Furthermore, lack of enough knowledge (29) and also a comprehensive program to cope with the paths of AIDS transmission between both residents of urban and rural areas in Iran's healthcare system deserves more attention.

High prevalence of tobacco consumption (27) in Bushehr province between both males and females is a major problem that dates back a long time ago and has still remained problematic and could be the most leading agent in catching lung cancer. People's unawareness of a direct link between lung cancer and smoking alongside fragmented inter-sectoral policies has potentially helped the sustainability of current situation.

In conclusion, this study found that, in spite of an increase in unavoidable deaths rate during 2004–2011 in Bushehr province, avoidable mortality rate significantly decreased and rural areas in comparison to urban areas have benefited more, totally indicating that the healthcare system has played an important role in the improvement of population health and the gap between rural and urban areas has been narrowed.

Limitations

Lack of information regarding households socioeconomic status was a huge hurdle that did not allow us to link avoidable mortality rate across socioeconomic groups. Quality of death certifications in terms of validity of major and underlying cause of deaths was a potential threat which could be effective in the findings of the study. Thus, interpretations should be done with caution. Under-reporting was also another threat which could influence the results but since death information was already gathered from all possible sources like cemeteries, hospitals, forensic medicine and healthcare centers, it can largely reduce underreporting defects.

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Ethical issues

This study was approved by the Ethics Committee of the Tehran University of Medical Sciences.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

HO was key author in designing research method, data collection and writing the manuscript, AP developed the idea of research and contributed in proposal writing and drafting the manuscript, HAA participated in designing study and revising the manuscript, HH helped in data analysis and revising proposal, ARF helped in data entry, conducted data analysis and interpretation and answering to reviewers' comments.

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